Abstract: Disclosed is a polymer or copolymer, which is produced from a norbornene monomer and a linear olefin compound, and exhibits superior heat resistance and optical properties and is thus suitable for use as a material for heat-resistant optical parts and electronic parts.
The present invention relates to a polymer or copolymer of a norbornene monomer and a linear olefin compound.

A copolymer of a cyclic olefin monomer, such as norbornene, with a linear olefin compound has transparency, heat resistance, chemical resistance, mechanical strength, and refractive index superior to those of conventional olefin polymers. Thus, such a copolymer may be used for pick-up lenses for cameras or DVDs, insulation films of semiconductors or TFT-LCDs, protective films of polarizers, multichip modules, integrated circuits (IC), printed circuit boards, sealants for electronic devices, or low-dielectric coating agents, films, and packages for flat panel displays or optical purposes, and may also be used as material for plastic substrates for flexible displays.

However, in order to serve for the above end uses, the norbornene copolymer, which is copolymerized from a norbornene monomer and a linear olefin compound, must be
guaranteed to have high optical properties, refractive index, and thermal stability. Linear olefin-norbornene copolymers known to date have a refractive index of less than 1.5 and a low glass transition temperature (Tg), and thus do not satisfy the requirements for the above end uses.

Typically, a polymer composed of a monomer having a bulky structure has a tendency to have a decreased glass transition temperature, and has undesirable thermal stability problems, and thus is regarded as unsuitable for use as an electronic material. However, the present inventors determined that, when a norbornene monomer into which a bulky substituent is introduced is formed into a copolymer along with a linear olefin compound, a glass transition temperature is somewhat increased, and thus confirmed that an optical material including the same exhibits superior optical properties and thermal properties, thereby completing the present invention.

[Disclosure]

[Technical Problem]

Accordingly, the present invention provides a norbornene polymer or copolymer, which is able to exhibit high heat resistance and optical properties despite being copolymerized with a linear olefin compound.

In addition, the present invention provides an
optical material having superior refractive index and light transmittance.

[Technical Solution]

According to an embodiment of the present invention, a norbornene homopolymer or copolymer may include a repeating unit represented by Formula 1 below:

Formula 1

\[
\text{R}_1 \text{R}_2 \text{R}_3 \text{R}_4
\]

wherein \( R_1, R_2 \) and \( R_3 \), which are the same as or different from each other, are a hydrogen atom, a \( \text{C}_{1-10} \) linear or branched alkyl group, or a \( \text{C}_{5-12} \) cyclic alkyl group, at least one of \( R_1, R_2 \) and \( R_3 \) not being a hydrogen atom, and \( R_4 \) is selected from among

\[
\begin{align*}
\text{R}_5 & \\
\text{R}_5 & \\
\text{R}_5 & \\
\end{align*}
\]

which \( R_5 \) is a hydrogen atom, a \( \text{C}_{1-10} \) linear or branched alkyl group, or a \( \text{C}_{5-12} \) cyclic alkyl group; \( n \) is an integer of 0 or more; and \( m \) is 1-5.

In the above embodiment, the molar ratio of a norbornene monomer to a linear olefin compound may be
The norbornene homopolymer or copolymer according to the above embodiment may have a glass transition temperature \((T_g)\) of 120°C or higher, a weight average molecular weight \((M_w)\) of 10,000 or more, and a molecular weight distribution of 1.0-4.0.

According to another embodiment of the present invention, an optical material may include the norbornene homopolymer or copolymer as above.

The optical material according to the above embodiment may have a refractive index of 1.5-1.7 and light transmittance of 0.9 or more, according to Equation 1 below:

\[
\frac{I_0 - (I_a + I_r)}{I_0} = T
\]

\(I_0\) = intensity of light incident perpendicular to a substrate

\(I_a\) = intensity of light absorbed by a substrate

\(I_r\) = intensity of light reflected from a substrate.

[Best Mode]

Hereinafter, a detailed description will be given of the present invention.

According to the present invention, the norbornene polymer is a homopolymer or copolymer including a repeating unit represented by Formula 1. The norbornene polymer is a
polymer of a cyclic norbornene monomer, into which an ester group and a bulky substituent are introduced, and a linear olefin compound, and has a weight average molecular weight of 10,000 or more, a molecular weight distribution of 1.0-4.0, and a glass transition temperature (Tg) of 120°C or higher.

The molar ratio of the norbornene monomer to the linear olefin in the produced homopolymer or copolymer is 10:90-99:1, and preferably 20:80-95:5, in the interests of the thermal stability of the copolymer. In particular, as the molar ratio of the norbornene monomer is increased, the thermal stability is increased, leading to a raised glass transition temperature.

The norbornene polymer according to the present invention is copolymerized from a monomer having the structure of Formula 2 below and a linear olefin compound:

**Formula 2**

![Diagram](image)

wherein R₁, R₂ and R₃, which are the same as or different from each other, are a hydrogen atom, a C₁⁻₁₀ linear or branched alkyl group, or a C₅⁻₁₂ cyclic alkyl.
group, at least one of $R_1$, $R_2$ and $R_3$ not being a hydrogen atom, and $R_4$ is selected from among

$$\begin{align*}
&\text{R}_5, \\
&\text{R}_5, \\
&\text{R}_5
\end{align*}$$

in which $R_5$ is a hydrogen atom, a $C_{10}$ linear or branched alkyl group, or a $C_{5-6}$ cyclic alkyl group; and $n$ is an integer of 0 or more.

The norbornene monomer of Formula 2 and the linear olefin compound are added to an organic solvent along with a catalyst, and are then polymerized. The norbornene monomer of Formula 2 and the linear olefin are adjustably added in order to satisfy the molar ratio of the norbornene monomer to the linear olefin in the produced homopolymer or copolymer.

The organic solvent is a hydrocarbon solvent. Alternatively, to dissolve a norbornene derivative containing an adamantyl group, alcohol may be used alone or in a mixture with water or another organic solvent such as tetrahydrofuran, other than the alcohol. As such, the alcohol is exemplified by methanol, ethanol, isopropanol, butanol, etc.

As the catalyst, a known metallocene compound may be used.

The catalyst and the reactive monomers, for example, the monomer of Formula 2 and the linear olefin compound, are preferably mixed at a molar ratio of 1:100-1:10,000.
In addition to the catalyst, a metallocene compound may be further used as a co-catalyst, as necessary.

The temperature for the polymerization of the linear olefin compound and the norbornene monomer of Formula 2 is -50-100 °C, and preferably -30-80 °C. Although the polymerization time varies depending on the type of polymerization material, the concentration of the catalyst, and the reaction temperature, it ranges from 5 min to 5 hours, and preferably from 10 min to 3 hours. The pressure is preferably set to 0-20 kg/cm².

The norbornene polymer having the repeating unit of Formula 1 has a weight average molecular weight (Mw) of 10,000 or more. Under typical polymerization conditions, a weight average molecular weight (Mw) falls in the range of 20,000-1,000,000. The molecular weight distribution is 1.0-4.0.

The norbornene polymer of the present invention has a glass transition temperature of 120 °C or higher, thus making it possible to provide a material having superior thermal stability. As the glass transition temperature is increased, thermal stability becomes superior. Hence, there is no need to confine the upper limit of the glass transition temperature.

In the present invention, the term "norbornene monomer" indicates a monomer containing at least one norbornene (bicyclo[2,2,1]hept-2-ene) unit, as represented
The norbornene monomer represented by Formula 2 may be obtained by subjecting cyclopentadiene (CPD), dicyclopentadiene (DCPD), or a mixture thereof, which is substituted or unsubstituted with an alkyl group, and alkylacrylate, having an adamantyl group, to a Diels-Alder reaction.

Specifically, CPD, DCPD or a mixture thereof, which is substituted or unsubstituted with an alkyl group, and alkylacrylate having an adamantyl group are reacted at a molar ratio of 1:0.5~10, and preferably 1:0.5~4.

The reaction temperature therefore is 180~220 °C, and the reaction pressure is atmospheric pressure or more.

When the monomer of Formula 2 is synthesized, a polymerization inhibitor may be added to adjust n in Formula 2 to a desired numeral. The polymerization inhibitor is selected from the group consisting of aniline, cyclohexane, phenol, 4-epoxyphenol, nitrobenzene, hydroquinone, benzoquinone, copper dichloride, and 2,2-di(4-tert-octylphenyl)-1-picrylhydrazyl, and preferably, hydroquinone or benzoquinone is used, but the present
invention is not limited thereto.

The polymerization inhibitor is added such that the molar ratio of the CPD, DCPD or mixture thereof, which is substituted or unsubstituted with an alkyl group, to the polymerization inhibitor is 1:0.001-0.05, and preferably 1:0.002-0.04.

The monomer thus obtained is represented by Formula 2. In Formula 2, at least one of R₁ to R₃, in particular, R₁, is not a hydrogen atom. This monomeric structure functions to increase the amorphous properties of a polymer having it as a repeating unit to thus increase light transmittance.

The norbornene polymer containing the repeating unit of Formula 1 is dissolved in the solvent, and is manufactured into a film or a sheet through a solvent casting process. As such, the polymer may be used in the form of a mixture of one or more kinds thereof. The manufactured film has a thickness of 50-500 µm, and light transmittance of 0.9 or more, according to Equation 1 below:

Equation 1

\[
\frac{I_0 -(I_a + \gamma \alpha)}{I_0} = T
\]

\[I_0 = \text{intensity of light incident perpendicular to a substrate}\]

\[I_a = \text{intensity of light absorbed by a substrate}\]
\[ l_r = \text{intensity of light reflected from a substrate} \]

The film or sheet has low water absorption and thus exhibits excellent dimensional stability.

[Mode for Invention]

A better understanding of the present invention may be obtained through the following examples, which are set forth to illustrate, but are not to be construed as the limit of the present invention.

Synthesis of Norbornene-Ester Monomer (Synthesis Examples 1-2 and Comparative Synthesis Example 1)

<Synthesis Example 1> Synthesis of 2-Methyl-2-Adamantyl-5-Norbornene-2-Methyl-2-Carboxylate

In a 0.25 \(^\text{L autoclave}\), DCPD (dicyclopentadiene, Aldrich, 10.2 ml, 0.0757 mol), 2-methyl-2-adamantylmethacrylate (42.6 g, 0.18 mol), and hydroquinone (0.83 g, 0.1 mol) were placed, and were then reacted at 180°C for 12 hours, after which the reaction product was cooled, transferred into a distiller, and subjected to vacuum distillation at 1 torr using a vacuum pump, thus obtaining a desired product at 110°C (yield: 25%). The molar ratio (mol%) of the exo isomer to the endo isomer of the product was 48.5:51.5.
1H-NMR (500MHz, CDCl₃), endo: 5.620 (dd, IH), 6.18 (dd, IH); exo: 6.12 (m, 2H)

<Synthesis Example 2> Synthesis of 1-Adamantyl-5-Norbornene-2-Methyl-2-Carboxylate

In a 0.25 l autoclave, DCPD (dicyclopentadiene, Aldrich, 10.2 ml, 0.0757 mol), 1-adamantylmethacrylate (40.0 g, 0.18 mol), and hydroquinone (0.83 g, 0.1 mol) were placed, and were then reacted at 200°C for 12 hours, after which the reaction product was cooled, transferred into a distiller, and subjected to vacuum distillation at 1 torr using a vacuum pump, thus obtaining a desired product at 100°C (yield: 85%). The molar ratio (mol%) of the exo isomer to the endo isomer of the product was 40.0:59.1.

1H-NMR (500MHz, CDCl₃), endo: 6.18 (dd, IH), 6.04 (dd, IH); exo: 5.612 (dd, IH), 6.04 (dd, IH)

<Comparative Synthesis Example 1> Synthesis of Norbornene-2-Carboxylic Acid Methyl Ester

In a 0.5 l autoclave, DCPD (dicyclopentadiene, Aldrich, 67 ml, 0.5 mol), methacrylate (Aldrich, 94.6 ml, 1.05 mol), and hydroquinone (2.3 g, 0.02 mol) were placed, and were then reacted at 200°C for 12 hours, after which the reaction product was cooled, transferred into a distiller, and subjected to vacuum distillation at 1 torr using a vacuum pump, thus obtaining a desired product at 50°C
(yield: 89%). The molar ratio (mol%) of the exo isomer to
the endo isomer of the product was 52.8:47.2.

$^1$H-NMR (500MHz, CDCl$_3$), endo: $6.17$ (dd, IH), $5.91$
(dd, IH); exo: $6.09$ (m, 2H)

**Synthesis of Linear Olefin Compound-Norbornene**

**Polymer (Examples 1-10 and Comparative Example 1)**

**<Example 1>**

The 2-methyl-2-adamantyl-5-norbornene-2-methyl-2-
carboxylate obtained in Synthesis Example 1, having a
concentration of 7.0 mol/l in a toluene solution, a
catalyst, for example, $7 \times 10^{-3}$ mol/l Cp$_2$ZrCl$_2$ in a toluene
solution, and a co-catalyst, for example, 0.2 mol/0
methylaluminoxane (MAO) in a toluene solution, were
continuously fed into the top of a 1 l glass polymerization
reactor equipped with a stirrer. Ethylene was fed into the
top of the polymerization reactor in an amount of 15 l over
1 hour, after which the polymerization was conducted for 1
hour while the polymerization temperature was maintained at
30°C.

The polymer thus obtained was measured for yield,
composition, molecular weight, and molecular weight
distribution, and the glass transition temperature (Tg)
thereof was determined using TGA (Thermogravimetric
Analysis) and DSC (Differential Scanning Calorimetry). The
results are shown in Table 1 below.

**<Example 2>**

Polymerization was conducted in the same manner as in Example 1, with the exception that ethylene was fed in an amount of 30 I over 1 hour.

The polymer thus obtained was measured for yield, composition, molecular weight, and molecular weight distribution, and the glass transition temperature ($T_g$) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

**<Example 3>**

Polymerization was conducted in the same manner as in Example 1, with the exception that ethylene was fed in an amount of 60 I over 1 hour.

The polymer thus obtained was measured for yield, composition, molecular weight ($M_w$), and molecular weight distribution, and the glass transition temperature ($T_g$) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

**<Example 4>**

Polymerization was conducted in the same manner as in
Example 1, with the exception that the l-adamantyl-5-norbornene-2-methyl-2-carboxylate obtained in Synthesis Example 2 was used instead of the 2-methyl-2-adamantyl-5-norbornene-2-methyl-2-carboxylate. The polymer thus obtained was measured for yield, composition, molecular weight (Mw), and molecular weight distribution, and the glass transition temperature (Tg) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

<Example 5>
Polymerization was conducted in the same manner as in Example 4, with the exception that ethylene was fed in an amount of 30 l over 1 hour.

The polymer thus obtained was measured for yield, composition, molecular weight (Mw), and molecular weight distribution, and the glass transition temperature (Tg) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

<Example 6>
Polymerization was conducted in the same manner as in Example 4, with the exception that ethylene was fed in an amount of 60 l over 1 hour.
The polymer thus obtained was measured for yield, composition, molecular weight ($M_w$), and molecular weight distribution, and the glass transition temperature ($T_g$) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

**<Example 7>**

Polymerization was conducted in the same manner as in Example 4, with the exception that propylene was used instead of ethylene.

The polymer thus obtained was measured for yield, composition, molecular weight ($M_w$), and molecular weight distribution, and the glass transition temperature ($T_g$) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

**<Example 8>**

Polymerization was conducted in the same manner as in Example 7, with the exception that propylene was fed in an amount of 30 $\ell$ over 1 hour.

The polymer thus obtained was measured for yield, composition, molecular weight ($M_w$), and molecular weight distribution, and the glass transition temperature ($T_g$) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry).
and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

<Example 9>

Polymerization was conducted in the same manner as in Example 7, with the exception that propylene was fed in an amount of 60 I over 1 hour.

The polymer thus obtained was measured for yield, composition, molecular weight (Mw), and molecular weight distribution, and the glass transition temperature (Tg) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

<Example 10>

A norbornene monomer mixture of the 2-methyl-2-adamantyl-5-norbornene-2-methyl-2-carboxylate obtained in Synthesis Example 1, having a concentration of 7.0 mol/l in a toluene solution, and 7.0 mol/l norbornene-2, 3-dicarboxylic acid anhydride (available from Aldrich) in a toluene solution, mixed at a ratio of 1:1, a catalyst, for example, 7.0X10^-3 mol/l Cp2ZrCl2 in a toluene solution, and a co-catalyst, for example, 0.2 mol/l methylaluminoxane (MAO) in a toluene solution, were continuously fed into the top of a 1 I glass polymerization reactor equipped with a stirrer. Ethylene was fed into the top of the
polymerization reactor in an amount of 15 l over 1 hour, after which the polymerization was conducted for 1 hour while the polymerization temperature was maintained at 30°C.

The polymer thus obtained was measured for yield, composition, molecular weight, and molecular weight distribution, and the glass transition temperature (Tg) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.

<Comparative Example 1>

Polymerization was conducted in the same manner as in Example 1, with the exception that the norbornene-2-carboxylic acid methyl ester obtained in Comparative Synthesis Example 1 was used instead of the 2-methyl-2-adamantyl-5-norbornene-2-methyl-2-carboxylate.

The polymer thus obtained was measured for yield, composition, molecular weight (Mw), and molecular weight distribution, and the glass transition temperature (Tg) thereof was determined using TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry). The results are shown in Table 1 below.
TABLE 1

<table>
<thead>
<tr>
<th>Polymer Yield (%)</th>
<th>Polymer Composition $^1$ (mol%)</th>
<th>Molecular Weight $^2$</th>
<th>Molecular Weight Distribution $^3$</th>
<th>Polymer Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex.1</td>
<td>45</td>
<td>46</td>
<td>54</td>
<td>63,000</td>
</tr>
<tr>
<td>Ex.2</td>
<td>51</td>
<td>37</td>
<td>63</td>
<td>72,000</td>
</tr>
<tr>
<td>Ex.3</td>
<td>64</td>
<td>29</td>
<td>71</td>
<td>100,000</td>
</tr>
<tr>
<td>Ex.4</td>
<td>43</td>
<td>49</td>
<td>51</td>
<td>73,000</td>
</tr>
<tr>
<td>Ex.5</td>
<td>55</td>
<td>32</td>
<td>68</td>
<td>86,000</td>
</tr>
<tr>
<td>Ex.6</td>
<td>67</td>
<td>25</td>
<td>75</td>
<td>98,000</td>
</tr>
<tr>
<td>Ex.7</td>
<td>38</td>
<td>37</td>
<td>63</td>
<td>53,000</td>
</tr>
<tr>
<td>Ex.8</td>
<td>44</td>
<td>28</td>
<td>72</td>
<td>65,000</td>
</tr>
<tr>
<td>Ex.9</td>
<td>50</td>
<td>25</td>
<td>75</td>
<td>55,000</td>
</tr>
<tr>
<td>Ex.10</td>
<td>57</td>
<td>58</td>
<td>42</td>
<td>67,000</td>
</tr>
<tr>
<td>C.Ex.1</td>
<td>52</td>
<td>49</td>
<td>51</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Note:  
$^1$ based on integration of $^1$H-NMR  
$^2$ polystyrene standard in THF solvent  
$^3$ a value of weight average molecular weight/number average molecular weight

Manufacture of Film

<Examples 11-20, Comparative Example 2>

Using the polymers obtained in Examples 1-10 and Comparative Example 1, respective films were manufactured. Specifically, each of the polymers obtained in Examples 1-10 and Comparative Example 1 was mixed with an organic solvent according to a composition shown in Table 2 below, to prepare a coating solution. Subsequently, the coating solution was cast on a glass substrate using an applicator (Yoshimitsu YBA-4), dried at room temperature for 1 hour, and then further dried at 100°C for 18 hours in a nitrogen atmosphere. Subsequently, the dried glass substrate was allowed to stand at -10°C for 10 sec, after which the film was removed from...
the glass substrate using a knife, thereby obtaining the transparent films of Examples 11-20 and Comparative Example 2, having uniform thicknesses, in which the thickness deviation was less than 5%, as shown in Table 2.

<table>
<thead>
<tr>
<th>Ex.</th>
<th>Used Polymer</th>
<th>Solvent</th>
<th>Thickness (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Polymer of Ex.1</td>
<td>THF:FOMEA=1:4</td>
<td>107</td>
</tr>
<tr>
<td>12</td>
<td>Polymer of Ex.2</td>
<td>THF:FOMEA=1:4</td>
<td>105</td>
</tr>
<tr>
<td>13</td>
<td>Polymer of Ex.3</td>
<td>THF:FOMEA=1:4</td>
<td>131</td>
</tr>
<tr>
<td>14</td>
<td>Polymer of Ex.4</td>
<td>THF:FOMEA=1:4</td>
<td>124</td>
</tr>
<tr>
<td>15</td>
<td>Polymer of Ex.5</td>
<td>THF:FOMEA=1:4</td>
<td>111</td>
</tr>
<tr>
<td>16</td>
<td>Polymer of Ex.6</td>
<td>THF:FOMEA=1:4</td>
<td>116</td>
</tr>
<tr>
<td>17</td>
<td>Polymer of Ex.7</td>
<td>THF:FOMEA=1:4</td>
<td>98</td>
</tr>
<tr>
<td>18</td>
<td>Polymer of Ex.8</td>
<td>THF:FOMEA=1:4</td>
<td>102</td>
</tr>
<tr>
<td>19</td>
<td>Polymer of Ex.9</td>
<td>THF:FOMEA=1:4</td>
<td>108</td>
</tr>
<tr>
<td>20</td>
<td>Polymer of Ex.10</td>
<td>THF:FOMEA=1:4</td>
<td>110</td>
</tr>
<tr>
<td>C.Ex.2</td>
<td>Polymer of C.Ex.1</td>
<td>THF:FOMEA=1:4</td>
<td>106</td>
</tr>
</tbody>
</table>

*THF: tetrahydrofuran
*FOMEA: propylene glycol methyl ether acetate

<Evaluation of Properties>

(1) Light Transmittance

Each of the films of Examples 11-20 and Comparative Example 2 was measured for the intensity of light incident perpendicular to a substrate, the intensity of light absorbed by a substrate, and the intensity of light reflected from a substrate at 400-800 nm using a hazemeter (Nippon Denshoku 300A). The measured values were substituted into Equation 1 below, thus determining light transmittance. The results are shown in Table 3 below.

Equation 1
\[
\frac{I_0 - (I_a + I_r)}{I_0} = T
\]

/\% = intensity of light incident perpendicular to a substrate
I\_a = intensity of light absorbed by a substrate
I\_r = intensity of light reflected from a substrate

(2) **Refractive Index**

Each of the films of Examples 11-20 and Comparative Example 2 was measured for refractive index using an Abbe refractometer and a sodium light source at 25°C. The results are shown in Table 3 below.

<table>
<thead>
<tr>
<th></th>
<th>Light Transmittance (T)</th>
<th>Refractive Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex.11</td>
<td>0.93</td>
<td>1.57</td>
</tr>
<tr>
<td>Ex.12</td>
<td>0.92</td>
<td>1.55</td>
</tr>
<tr>
<td>Ex.13</td>
<td>0.94</td>
<td>1.53</td>
</tr>
<tr>
<td>Ex.14</td>
<td>0.94</td>
<td>1.58</td>
</tr>
<tr>
<td>Ex.15</td>
<td>0.91</td>
<td>1.55</td>
</tr>
<tr>
<td>Ex.16</td>
<td>0.92</td>
<td>1.54</td>
</tr>
<tr>
<td>Ex.17</td>
<td>0.93</td>
<td>1.55</td>
</tr>
<tr>
<td>Ex.18</td>
<td>0.91</td>
<td>1.51</td>
</tr>
<tr>
<td>Ex.19</td>
<td>0.90</td>
<td>1.51</td>
</tr>
<tr>
<td>Ex.20</td>
<td>0.93</td>
<td>1.55</td>
</tr>
<tr>
<td>C.Ex.2</td>
<td>0.89</td>
<td>1.49</td>
</tr>
</tbody>
</table>

As is apparent from the results of the evaluation, in the case of the norbornene copolymers copolymerized from the norbornene monomer, having a bulky substituent, and the linear olefin compound, the glass transition temperature could be seen to be increased more than in the case of the...
comparative example, in which the norbornene monomer having no bulky substituent was used. As the molar ratio of the norbornene monomer in the polymer was increased, the glass transition temperature was increased.

Further, it can be seen that the films, which were manufactured from the copolymers of the norbornene monomer having a bulky substituent and the linear olefin compound, had higher light transmittance and refractive index than in the case in which the norbornene monomer having no bulky substituent was used.

Thus, even when the linear olefin compound and the norbornene monomer are copolymerized, thermal stability can be increased, and furthermore, superior optical properties can be provided.

[industrial Applicability]

As described hereinbefore, the present invention provides a norbornene homopolymer or copolymer, which is copolymerized from a norbornene monomer having a bulky substituent and a linear olefin compound. Thereby, the norbornene homopolymer or copolymer can exhibit superior heat resistance and optical properties and is thus suitable for use as material for heat-resistant optical parts and electronic parts.
[CLAIMS]

[Claim 1]

A norbornene homopolymer or copolymer, comprising a repeating unit represented by Formula 1 below:

\begin{equation}
\text{Formula 1}
\end{equation}

wherein \( R_1, R_2 \) and \( R_3 \), which are same as or different from each other, are a hydrogen atom, a \( \text{C}_{1-10} \) linear or branched alkyl group, or a \( \text{C}_{5-12} \) cyclic alkyl group, at least one of \( R_1, R_2 \) and \( R_3 \) not being a hydrogen atom, and \( R_4 \) is selected from among \( \text{C}_{5-10} \) linear or branched alkyl group, or a \( \text{C}_{5-12} \) cyclic alkyl group; \( n \) is an integer of 0 or more; and \( m \) is 1-5.

[Claim 2]

The norbornene homopolymer or copolymer according to claim 1, wherein a molar ratio of a norbornene monomer to a linear olefin compound is 10:90-99:1.
[Claim 3]

The norbornene homopolymer or copolymer according to claim 1, which has a glass transition temperature (T_g) of 120°C or higher.

[Claim 4]

The norbornene homopolymer or copolymer according to claim 1, which has a weight average molecular weight (M_w) of 10,000 or more, and a molecular weight distribution of 1.0-4.0.

[Claim 5]

An optical material, comprising the norbornene homopolymer or copolymer of any one of claims 1 to 4.

[Claim 6]

The optical material according to claim 5, which has a refractive index of 1.5-1.7.

[Claim 7]

The optical material according to claim 5, which has a light transmittance of 0.9 or more, according to Equation 1 below:

Equation 1
\[ \frac{l_0 - (l_\alpha + l_r)}{l_0} = T \]

\[ l_0 = \text{intensity of light incident perpendicular to a substrate} \]

\[ l_\alpha = \text{intensity of light absorbed by a substrate} \]

\[ l_r = \text{intensity of light reflected from a substrate}. \]
INTERNATIONAL SEARCH REPORT

International application No
PCT/KR2007/006021

A. CLASSIFICATION OF SUBJECT MATTER

C08G 61/08(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 C08F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS, PAJ, REGISTRY(STN), CA(STN)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search
18 FEBRUARY 2008 (18 02 2008)

Date of mailing of the international search report
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Name and mailing address of the ISA/KR
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Facsimile No 82-42-472-7140

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